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ABSTRACT

This report focuses on distance learning projects conducted by the Centers for Professional Development of Teachers (CPDTs) in Texas, examining projects that closely interface with CPDTs, emphasizing the trends and issues that have emerged, and noting the effect these projects have had on education in general. The report begins by describing the technology of distance learning. This section explains that distance learning has the potential to revolutionize the American education system by offering ready access to formerly inaccessible educational services, connecting people who can learn from one another, and increasing the use of technology and pedagogies that promote student-centered instruction. Barriers to distance learning include cost, lack of cooperation among institutions of learning, and the need for training. The CPDTs have played an important role in purchasing and installing systems, modeling teaching methods, and exploring policies and procedures that best undergird distance learning. This report presents brief profiles of some of the CPDT projects to illustrate the degree of technical experimentation that has occurred and the impact of distance learning at various Texas teacher education institutions. A glossary of terms is provided. (Contains 20 references.) (SM)

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Restructuring Texas Teacher Education Series **5**

Distance Learning

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CENTERS FOR PROFESSIONAL DEVELOPMENT OF TEACHERS

In 1991 the Texas Legislature passed legislation and authorized funding for the Centers for Professional Development of Teachers (CPDTs; originally called Centers for Professional Development and Technology). The CPDTs are designed to support collaboration among public schools, universities, regional education service centers, and other organizations to improve teacher preparation and professional development.

The purpose of the CPDTs is to totally restructure teacher education on the basis of six principles and goals:

- To restructure teacher preparation programs toward performance-centered, field-based models
- To institutionalize the new programs to include all prospective teachers for the long term, not just pilot groups for a short period
- To integrate technology into teacher preparation and to support its enhanced use in PreK–12 schools
- To prepare teachers to address the needs of culturally diverse student populations
- To extend collaboration among universities, schools, and others concerned with teacher preparation
- To establish staff development opportunities that better address the needs of all educators

In 1992 the state funded the first 8 CPDTs. By 1993 the number had increased to 14, and by 1997, to 30. The CPDTs now comprise 43 universities, 15 regional education service centers, and 113 school districts, affecting more than 300,000 students, 19,000 teachers, and 12,000 preservice teachers. The names and the locations of the CPDT universities appear on the inside back cover of this publication. The commitment by the state legislature has been significant, as indicated by the $46 million that it has provided to date.

ABOUT THIS SERIES

This series of seven reports on restructuring teacher education in Texas was produced by representatives of seven CPDT institutions that received 1997–98 grants for Partnerships for Professional Development of Teachers. The series draws on experiences of all the CPDTs, including both successes and challenges.

The seven reports are as follows:

- Field-Based Teacher Education
- Professional Development Schools
- Connecting to Improve Methods Courses
- Assessment
- Distance Learning
- Cultural Pluralism
- Technology

Distance Learning: The Educational Impact of an Evolving Technology

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INTRODUCTION

Two-way communication across time and space is an old idea, but not until relatively recently has technology provided the means to carry it out with both audio and video transmission. In Aeschylus's *Agamemnon* the ancient Greeks ignited bonfires on the headlands all down the coast of Greece to spread the word that the Trojan War was over and the warriors were on their way home. Technology did not progress substantially past that point until the late 19th century. Then the telegraph, the telephone, and the television successively perfected the techniques of distance communication, delivering notice of the end of World Wars I and II and the Vietnam War more and more quickly, and in greater and greater graphic detail.

Such achievements have in turn allowed educators to conceive of the possibility of "distance learning." Distance learning is defined in this report as planned educational activity in which participants are separated by time and/or space. The technology to support distance learning has evolved during the 20th century and continues to do so at a rapid pace. Correspondence courses, originated in the 19th century, still exist, although now they frequently are supported by facsimile (fax) and telephone interaction. One-way delivery of instruction by television and satellite became the norm in the 1970s, and it continues to be used. However, in the late 1990s, more sophisticated technology makes possible two-way audio and video transmission. Today, distance-learning classrooms are electronically equipped so that an instructor and remote students (even in several locations) see, hear, and converse via camera, microphone, and video monitor. In addition, both instructor and students can display materials for everyone to see: computer graphics, written documents, videocassettes, and more. Although there are different definitions and interpretations of distance learning, this report focuses on distance-learning initiatives that use electronic means to achieve two-way interaction. In many instances the initiatives supplement interactive video with other technologies, such as the World Wide Web, E-mail, computer bulletin boards and chat rooms, CD-ROMs, and print.

Even though distance learning is relatively new, much research on its educational effectiveness already has accumulated, and the basic question of whether it is as effective as face-to-face instruction has been answered. In an ongoing meta-survey of studies that compare the end-point learning of students in distance-learning and traditional

> ***"Distance learning is best viewed not as an end in itself but as a technology-based delivery system."***

classrooms, Russell (1996) has consistently found no significant difference: students perform equally well on tests and other end-of-course assessments. The two types of instruction do seem to differ on some other important dimensions, however. Course dropout or noncompletion rates are higher in distance learning than in traditional instruction. In general, educators can infer that students in a distance-learning classroom may not feel a personal bond with the instructor or the institution comparable to that in a traditional classroom.

Students tend to prefer interactive video to less interactive forms of distance learning, and they complete video courses at a higher rate than correspondence or other types of distance-learning courses (Moore & Kearsley, 1996). But, in general, students evaluate courses on the basis of the quality of the content, not the delivery method or the technology (*Video Teletraining*, n.d.). Students even forgive the technical problems that sometimes plague interactive video transmission. As one insightful student recently commented,

> One of the things that tempers my response [to technological difficulties in class] is that this is not the way distance learning will be forever. It will be much improved. I'm just a traveler through this dimension for a short time, and I know it will get better for the folks who follow me. (Smith, 1997, p. 173)

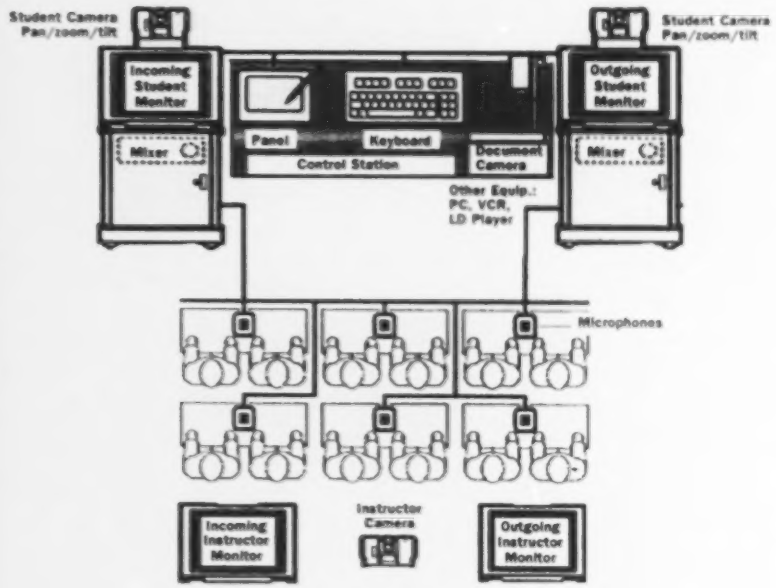
Equipment for distance learning by interactive video began to be available in the late 1980s. Marketers and futuristic thinkers already were envisioning some of the effect that such technology might have on education. In Texas, farsighted decision makers used the Centers for Professional Development of Teachers (CPDTs; originally called Centers for Professional Development and Technology) to further the development of distance learning. This report focuses on distance-learning projects conducted by the CPDTs and projects that closely interface with CPDTs, emphasizing the trends and the issues that have emerged and the effect that these projects have had on education in general. First, however, the report describes the technology of distance learning and explores the potential of this delivery system for education.

THE TECHNOLOGY OF DISTANCE LEARNING

Distance learning is best viewed not as an end in itself but as a technology-based delivery system. So at the outset it may help readers to understand the technology of distance learning.

A typical interactive distance-learning classroom (see Exhibit 1) is equipped with several video monitors. There usually are two at the front

Exhibit 1
A Typical Interactive Video Distance-Learning Classroom



of the room, an "outgoing monitor" displaying the video being sent from the local site and an "incoming monitor" showing the image being received from a distant site (usually a view of participants, who often are students). A control panel allows the incoming monitor to display a "split screen" so that several remote sites can be seen at once. Two monitors at the rear of the room also display the outgoing and incoming images so that the instructor or the leader (or anyone else standing at the control panel) can view the two-way interaction easily.

Three cameras are mounted around the room. One usually is trained on the instructor or a presenter, and another on the participants. The third, a "document camera" (see Glossary), allows the display of text, pictures, or small objects on the monitors. Typically, all cameras can pan, tilt, and zoom to follow a presentation.

Additional equipment may include a computer, a laser disc player, a videocassette recorder, and more cameras. For example, some sites specially rigged for medical teaching may have microscopes or probes equipped with cameras.

Audio is transmitted through microphones. They may be mounted on the tables for participants or hung from the ceiling. The instructor or a presenter often wears a "lavalier microphone" (a small microphone that hangs around the neck) to ensure that his or her voice is picked up anywhere in the room. On a cart, or in a control room on a console, is the control panel, which is used to operate all the equipment—for example, to manipulate cameras, and to select what will be displayed on monitors. The control panel may be a mechanical switching device, a software-based touchscreen, or even a keyboard and mouse.

How does all this equipment work in a distance-learning session? To begin, the instructor may display his or her image on the monitor for an introduction, then switch the display to participants at a remote site so that they can introduce themselves, and finally display participants at the originating site. When the time comes for a lecture or a presentation, the camera may focus on the instructor, or it may show a Powerpoint (software) presentation fed from the instructor's personal computer and accompanied by a live voice-over. When discussion occurs, a split screen may show participants at several sites simultaneously. When a speaker is recognized, the instructor may display only that speaker's site. For participants' presentations, participants may train the camera on themselves, display a graphic, or demonstrate a laboratory technique using the document camera. In short, multiple electronic connections permit distance-learning classrooms to be fully interactive, supporting very nearly the same kind of person-to-person interactions found in any traditional learning situation. The equipment used for course delivery can be used for various other kinds of interactions: meetings of principals in a school district, training sessions for faculty, classroom observations, collaborative projects, even job interviews.

"The equipment used for course delivery can be used for various other kinds of interactions: meetings of principals in a school district, training sessions for faculty, classroom observations, collaborative projects, even job interviews."

Distance-learning sites may be connected in several ways. The type of connection significantly affects the quality of the video transmitted, the kind of equipment purchased for the classrooms, and the cost of the operation (see Glossary). The line speed of the connection is critical to the quality of video transmission. For classroom interaction, a transmission rate of 128 kilobytes per second (Kbps) is the lowest acceptable speed and video quality. At present, a rate of 384 Kbps is the standard for interactive classrooms; however, rates of 512 Kbps and 786 Kbps are possible and provide higher-quality video.

A variety of connections providing different line speeds are currently in use. The most common connection is a T1 line, which transmits video at a rate of 1.544 megabytes per second. A T1 line is a

trunk telephone line, which must be specially installed. Highest reliability and highest cost come from dedicated fiber optic lines, which transmit at a rate of 2.5 gigabytes per second and provide television-quality video. A fiber optic connection must be specially laid, and laying it is expensive, generally beyond the budgets of schools and universities. Integrated systems digital network (ISDN) telephone lines, already in place, provide dial-up service that allows a site to connect to any other site with compatible equipment. Cost is directly related to time of use (daytime, evening, etc.) and corresponding long distance rates. The increasing availability of ISDN lines has promoted the popularity of this configuration. Two-site, or "point-to-point," connections can be made directly. If three or more sites need to communicate, the sites all dial in to a "bridging" site with relay equipment.

Desktop videoconferencing using the Web is another technology coming into common use. A small camera attached to a personal computer with appropriate software allows one or two people at each site to be seen on the computer screen at a remote site and to be heard via the computer microphones. This is a very inexpensive way of achieving interactive connection.

Other technologies often used in conjunction with interactive video are telephone, fax, and Web-based text communication via E-mail, bulletin boards, and chat rooms.

Between on-camera classes, students can participate in on-line chat groups about readings, use E-mail to send questions and topics for discussion to the instructor, or post writing assignments to the class Web site, where other students can read the material and respond. Supplementary technologies like the Web, E-mail, and multimedia are so closely tied to distance learning that this report includes them in its discussion. Indeed, in recent years, most universities have offered classes based entirely on the Web (with no video connection). New "electronic universities" have been established that offer their entire curricula over the Web.

Educators contemplating the purchase of distance-learning equipment face a complex range of choices. In addition to the general type of system and connection, the quality of equipment is important and affects the student experience. Some CPDTs have explored the practicality of different equipment configurations and their suitability for specific uses. Over the past five years, this experimentation has produced a body of professional experience on which universities and PreK–12 schools alike are relying.

THE POTENTIAL OF DISTANCE LEARNING

Distance learning in the computer age has the potential to revolutionize the American education system in three ways: (1) by providing ready access to formerly inaccessible educational services; (2) by connecting people who can learn from one another (e.g., teachers and learners, students and students, experts and novices, and schools and schools); and (3) by increasing the use of technology and pedagogies that promote student-centered education.

Access

Distance learning has the capacity to offer learning in places and ways convenient to the learner—on site or on-line at flexible times. This technology can bring together students who exist in small, geographically scattered groups—students who are academically gifted, for example, or students who are hearing impaired. Distance learning also can make education available to persons who previously did not have access to it because of time or geographic limitations—for example, high school students who are able to do college work but cannot leave their high schools during the school day, and teachers who want to take a graduate course but cannot find time to drive to a university.

Closely allied to access in convenient places at convenient times is access to people and other resources that are difficult or almost impossible to find. For example, via a distance-learning system, a NASA expert on moon rocks can work with a seventh-grade earth science class on beginning geology. This kind of potential is particularly critical for rural areas, which have not in the past had equal access to educational resources. Hence the access that distance learning provides can improve equality of opportunity for people across the state.

Connection

Distance learning has the potential to connect people who have previously been isolated. In a state as large as Texas, people have long taken a certain degree of isolation for granted: the geographic isolation of students on west Texas ranches, who ride a bus two-and-a-half hours to school each way, or the monocultural isolation of children in the inner city or the upper-class suburbs. Only as educators confront the possibility of every school building in Texas being connected to every other, do they begin to appreciate the isolation in which they have been operating. Schools will be able to form electronic communities. Such connections can promote cultural awareness and allow students from widely separated regions in and out of the state to learn together. Distance learning also can promote school-university collaborations as institutions work together to improve public education. Further, it has the potential to affect teacher education substantially by tying together colleges and public schools. Teacher education students who observe and analyze PreK–12 class-

> ***"This technology can bring together students who exist in small, geographically scattered groups—students who are academically gifted, for example, or students who are hearing impaired."***

rooms are much better able to integrate the theory they study at the university with the practice they see the schoolroom.

Pedagogical Change

Distance learning using interactive video also has the potential to supplant traditional lecture-style, teacher-centered classrooms. Transformation of practice already proceeds in many traditional classrooms, but at a glacially slow rate. Despite a growing body of research documenting the need for active learning and teacher planning in response to students' needs, "instruction in industry and on campuses remains virtually unchanged from twenty-five years ago" (Dooley, 1996, p. 5).

Distance-learning classrooms are more likely than traditional classrooms to be technology rich. The availability of the laser disc player, the personal computer, and the document camera, and opportunities for multimedia training and Internet access, can lead to better teaching. The promise of multimedia, which has been only partially realized in traditional classrooms, is likely to be more fully realized in distance-learning settings because of greater availability of equipment and training (Adams & Irwin, 1997; Clark, 1997). Finally, as teachers master the technological and interactive skills needed for distance learning, they will transfer those skills to instruction in general.

BARRIERS TO DISTANCE LEARNING

Distance learning's potential is not yet realized, however, and there are significant barriers to its full achievement. The most prominent ones are high cost, lack of cooperation among institutions of learning, and the need for training.

Cost

At present, the cost of distance-learning equipment for a single site is approximately $30,000. In addition to start-up outlays for equipment and installation, there are continuing expenses for line charges, training, and upgrading of hardware and software. Specialized training for administrators and teachers is especially important. All of this requires a major budget commitment. Hence it can be difficult to justify the expense to a small university or a public school. Economies of scale eventually come into play in very large distance-learning systems, but they are not evident immediately.

Lack of Cooperation

Regarding lack of cooperation, the essential contribution of distance learning is to connect people and institutions. The positive value of connection is balanced by the organizational complications and the difficulties that can plague relationships. Different goals, different management styles, and different schedules all must be reconciled if cooperative relationships are to be successful.

Need for Training

The training challenge related to distance learning is substantial. American schools have routinely underestimated the amount of training that teachers need to become proficient at new skills. Cunningham and Bernshausen (1997) indicate that teachers require about 80 hours of training and four to five years of routine experience to become proficient at integrating computer technology into their classrooms. Teaching on a distance-learning system can require computer technology skills, multimedia production skills, and specialized training on the control panel in use at the site. Some institutions provide technical support personnel to assist the instructor, but many do not. Schools and universities must be willing to invest the time and the money needed to train instructors and technical support personnel.

DISTANCE-LEARNING INITIATIVES OF THE CPDTS

Exploring the implementation challenges and the educational effects of distance-learning programs has been a particular charge of the CPDTs. These centers focus on restructuring teacher education, with an emphasis on the use of technology in the public schools and the university. Many of the CPDTs have received funds expressly designated for distance-learning facilities, and their efforts have jump-started distance learning in the state. From the outset the intent has been to influence an entire university, not just the teacher education program. Already, some of the distance-learning programs initiated by the CPDTs have grown into large-scale programs sponsored by their universities. The primary uses of the systems are dual-credit courses for high school students, specialized courses such as nursing and graduate studies, and sharing of high school teachers in high-demand subjects such as advanced mathematics and science.

The CPDTs have played an important role in purchasing and installing systems, modeling teaching methods using the emerging technologies, and exploring policies and procedures that best undergird distance learning. They also have played a critical role in establishing and maintaining the collaborative relationships necessary to support distance learning.

CPDT Projects

Brief profiles of some CPDT projects illustrate the degree of technical experimentation that has taken place. The projects use a variety of distance-learning equipment and connections, focus on different types of users, and serve diverse purposes.

Spindletop CPDT

At Lamar University in Beaumont, the Spindletop CPDT formed a partnership with Southwestern Bell to create a distance-learning

system. It is modest but useful and well established. To demonstrate the usefulness of high-tech equipment, Southwestern Bell gave Lamar University free access to a fiber optic line from the university to a rural high school in Buna, about 50 miles away, and installed state-of-the-art video equipment at both locations. Using this reliable and user-friendly system, the university has delivered 12 hours of university course work to the Buna site each semester. Courses have ranged from basic composition and government to education of hearing-impaired students and graduate courses in education. The link also has provided vocational training such as short courses on the enforcement of environmental protection regulations; cultural enrichment activities for elementary school students; and seminars for PreK–12 teachers on subjects such as mathematics manipulatives and use of technology. The fiber optic video connection is supported by fax, telephone, and a person who delivers materials. A facilitator at the high school oversees the class, distributes materials, and proctors examinations.

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One of the best qualities of this system has been reliability. Because the system operates on buried fiber optic lines, the connection has been virtually problem free. Today, although it is over three years old, it still represents state-of-the-art technology and provides the highest-quality video and audio transmission.

This point-to-point system has provided Lamar and the Spindletop CPDT with the knowledge and the experience to branch out into other distance-learning efforts. In the College of Arts and Sciences, the School of Nursing now uses a dedicated T1 line to connect to the University of Texas Medical Branch at Galveston, some 100 miles away. The College of Education has acquired videoconferencing equipment capable of operating on both dial-up connections and dedicated lines. This system is used for training in distance teaching, collaboration with other teacher education institutions, and interaction with professional development schools. Lamar offered its first graduate course on distance learning in 1997.

Stephen F. Austin State University CPDT

A sponsor of one of the first CPDTs, Stephen F. Austin State University immediately put into place a two-site videoconferencing system, which has since grown to encompass several sites. Originally it linked Stephen F. Austin by T1 line to Angelina Junior College, 20 miles away. Soon there also was a connection to the Region VII Service Center in Kilgore, 60 miles away, and the University of Texas Medical Branch in Galveston, 300 miles distant.

"The Stephen F. Austin State University CPDT also has used the system to deliver college classes to high schools and to the Region VII Service Center."

The system has been especially useful to the university's nursing program, by allowing students at the junior college site to work with nursing instructors from the two universities. The CPDT also has used the system to deliver college classes to high schools and to the Region VII Service Center. The system now has expanded to include Web-based desktop videoconferencing equipment. Partners report that the conferencing capability may be the most useful feature of the system. The CPDT distance-learning facility has become totally institutionalized as part of a university-wide distance-learning division.

Southwest Texas State University CPDT

Southwest Texas State University, a major producer of teachers and the sponsor of another of the first-generation CPDTs, focused on a different need by designing distance-learning links between the university, PreK–12 schools, and a local Job Corps training site ("Technology Plays a Major Role," 1995). The effort began with a project on algebra called PATHMATH, which used interactive audio and two-way video between the university and the high school. With the inception of the Southwest Texas State CPDT in spring 1993, interactive television classrooms using fiber optic technology were installed at Bowie Elementary School, the Gary Job Corps, and the Southwest Texas State School of Education, to create the TeleCommUNITY network. It was sponsored by San Marcos Telephone Company, now a part of Century Telephone Company. The hookup uses interactive video, videotape and laser disc players, and a computer-video interface. Purchase of relatively inexpensive equipment and connections has kept the cost as low as possible. The CPDT uses the hookup to conduct and monitor classes for prospective teachers working at Bowie Elementary, to provide training for students at Gary Job Corps, and to support professional development for educators at all sites.

The long-range plan for the TeleCommUNITY network is expansion to more distant elementary and secondary schools so that Southwest Texas State's teacher education division can collaborate with a greater number of public schools in preservice and inservice teacher education. Because of inadequate funding, expansion has been slow. However, in summer 1997 the CPDT secured funding to establish a T1 link to Round Rock Independent School District, some 100 miles away, and to downtown Austin.

Rice University CPDT

Project OWLink, administered by the Rice University CPDT, connects a growing number of Houston schools to Rice and to schools of the South Texas Independent School District, located in the Rio

Grande Valley, 500 miles south. Fiber optic lines link the schools in Houston, T1 connections the schools in south Texas. The technology allows Project OWLink to organize and promote several kinds of interactions. In two-week summer workshops over the distance-learning link, the project trains PreK–12 teachers to incorporate computing-and networking technology into their classrooms. Teachers from south Texas as well as Houston learn how to conduct classes using the OWLink system, how to use the Web as a teaching and publishing tool, and how to use the Internet in teaching. The training helps teachers develop the competencies that OWLink has designated as essential (**http://cttl.rice.edu/owlink/cc.html**) (see Exhibit 2). During this training, teachers prepare lesson plans that incorporate elements of the Internet, the Web, and distance learning, and publish those plans at a Web site (**http://www.rice.edu/armadillo/Owlink/less.shtml**).

The OWLink project also provides expert speakers to interact with all interested schools, promotes collaborative projects between teachers and classes, and, through regularly offered Web "camps," trains students in technology applications to improve achievement in mathematics and writing.

Large-Scale Networks

Some universities whose CPDTs pioneered distance learning have subsequently established large-scale distance-learning networks to serve their institution at large, rather than just the CPDT or the college of education. Two such projects are Texas A & M University's Trans-Texas Videoconference Network (TTVN) and Baylor University's IDEASnet. Both of these initiatives have built on the collaborations pioneered by the CPDTs. Such projects take distance learning to a new scale of operation, transcending regions and serving purposes beyond teacher education. They illustrate a dominant trend of distance learning in 1997, toward greater access and more extensive connections, and toward an organizational entity that links individual institutions. Commonalities between public schools and universities become more evident as universities begin to deliver their courses routinely in high schools, and university students routinely observe classrooms in PreK–12 schools.

Texas A & M University's TTVN

Texas A & M's TTVN is ambitious in scope, as befits one of the major institutions of higher education in the United States. The network began in 1990 with 11 Texas A & M campuses. As of 1996, it supported 158 telecourses, with a total of 3,518 videoconferences, and as of July 1997, it had 67 hookup sites, with 8 gateway connections in 29 cities, including Mexico City. The scheduling on TTVN is so complex that in 1996 it instituted a new scheduling system to accommodate the

Exhibit 2
OWLink Core Competencies

Efficient Internet Consumption

How to effectively use the Internet in your teaching
  Navigating and bookmarks
Search strategies, finding information on the Web
  Search engines; indexes, K-12 resources

Using the Web as a Teaching and Publishing Tool

Production of material for the Web
  Page design; examples of teacher presence on the Web
Web authoring and graphic techniques
  HTML; Photoshop; Graphic Converter; Transparency
Creating your own online Web resources
  Examples of excellent teacher work; FTP; Unix
Copyrighting your materials
  Giving credit to the project; signature at the end of the page

Teaching via the OWLink System—Beyond Teledistance

Using the OWLink system
  The podium; the AMX box
Critical teaching styles while teaching with OWLink
Introducing multimedia teaching into your classroom
Learning processes and procedures for online collaboration
Creating online projects with other teachers
Communication
  E-mail; Telnet protocols; listservs; OWLink listserv; Collaborative Technologies (Roundtable)

Dissemination/Professional Collegiality

Publishing work in journals/newsletters
Listserv ownership-rotation
Presentations in professional associations
Training during the year; roles and responsibilities

needs of both regularly scheduled university courses and one-time teleconferences on hundreds of topics. TTVN now uses a computerized scheduling system, and this year it began automating connection and disconnection of all sessions (*TTVN Annual Report*, 1996).

Texas A & M's chief use of TTVN has been to deliver courses more widely. Regularly scheduled telecourses—from nutrition to communications to agriculture—have grown steadily, reflecting a strong demand for greater availability of university instruction. In response, the university is planning several degree programs that will be offered entirely over the distance-learning system. Soon a student in the Panhandle will be able to earn a degree from Texas A & M at College Station, more than 500 miles south.

TTVN also delivers special teleconferences on topics from international relations to veterinary science. Further, it links the PreK–12 schools in the Texas A & M CPDT to one another and to the university for special project work and inservice training of teachers (**http://ttvn.tamu.edu**).

> ***"TTVN links the PreK–12 schools in the Texas A & M CPDT to one another and to the university for special project work and inservice training of teachers."***

Baylor University's IDEASnet

Operating on a smaller scale, but closely tied to the needs of its faculty and CPDT, is Baylor's IDEASnet. As of spring 1997, this videoconferencing and distance-learning center linked eight sites in the Waco area through a central dial-out hookup at Baylor that allows them to connect to compatible videoconference sites via ISDN line.

Baylor is connected to two PreK–12 schools in a network called the PARTNERS Project. This three-way hookup contributes significantly to Baylor's field-based teacher education program. The United States Distance Learning Association recently awarded the PARTNERS Project first place in Organizational Excellence.

IDEASnet is part of Project IDEAS (**http://diogenes.baylor.edu/~IDEAS/**), which researches, plans, and deploys distance-learning initiatives within the university. Current growth includes additional connections on the Baylor campus. Further, there are plans to establish a distance-learning classroom in each instructional building and to create connections to the Baylor School of Nursing in Dallas, TTVN, Texas State Technical College in Waco, and the Rio Brazos Educational Cooperative.

Related Projects

Two Texas projects not sponsored by CPDTs deserve mention because they closely interface with CPDT distance-learning efforts: the Texas Educational Teleconferencing Network (TETN) and the Southeast Texas Telecommunications Education Network (SETTEN).

Texas Educational Teleconferencing Network

TETN connects 20 regional service centers and the Texas Education Agency in Austin. Highly cost-efficient, it has saved thousands of hours of travel time by allowing training and meetings of service center and school district personnel via distance hookup. The network is available for use by PreK–12 schools, institutions of higher learning, and other education-related groups. In fact, most service center sites now are fully scheduled months in advance. The network has provided an effective venue for distribution of educational information and updates from the Texas Education Agency. Currently most of the regional service centers are expanding their videoconferencing capabilities

> ***"A survey of CPDTs highlights several common themes in these programs: growing use of interactive video in the universities, particularly in teacher education; a trend toward Web-based desktop videoconferencing to promote person-to-person contacts; and a continuing commitment to distance learning as a critical feature of teacher education and education reform."***

and seeking wider uses for their systems. This state-funded network was an excellent early model of the advantages and the possibilities of distance-learning connections.

The economic considerations for the regional service centers are not the same as those for schools and universities, of course. The service centers have traditionally paid the cost of their employees' travel to training. Hence they can save considerable money by implementing training via distance learning. Schools and universities have traditionally paid little or nothing for faculty training; the individuals involved have generally absorbed the cost. Hence the institutions save nothing when such training is more easily available. Similarly, university students have paid their own transportation costs to class. The university saves nothing by making classes more convenient unless enrollment increases.

Southeast Texas Telecommunications Education Network

The second project, SETTEN, is still in the planning stages. This system will provide an all-service telecommunication infrastructure for the PreK–12 schools in the area served by the Region V Service Center. Thus it will provide E-mail, data transmission, and Internet connections, as well as distance learning. Begun in 1996, this collaborative endeavor will be fully operative in 1998. The plan is likely to be replicated in other service center regions, providing a logical local extension of the statewide service center network already in place. The project seeks to create "a telecommunications infrastructure which will be compatible with other regional, state, national and international telecommunications networks" (*SETTEN*, 1997, p. 2). This kind of interlocking, compatible networking begins to approach the full capacity of access to distance learning, which will be the norm in the coming century.

THE IMPACT OF DISTANCE LEARNING

Distance-learning programs such as those just described have effectively demonstrated that distance learning can realize its anticipated promise. A survey of CPDTs conducted in spring 1997 by Aileen Johnson of the University of Texas at Brownsville highlights several common themes in these programs: growing use of interactive video in the universities, particularly in teacher education; a trend toward Web-based desktop videoconferencing to promote person-to-person contacts (e.g., to connect school principals to district headquarters and to a university); and a continuing commitment to distance learning as a critical feature of teacher education and education reform.

Sixteen CPDTs have two or more distance-learning units connected to junior colleges, other colleges, or public school campuses (Johnson, 1997). Most of these centers use dedicated T1 lines. Four centers use desktop videoconferencing equipment, and several others are now purchasing such hardware.

Johnson reports that currently the primary use of interactive video equipment is to offer university courses at remote sites, often including concurrent enrollment in university courses for high school students. Other common uses include videoconferencing among universities, between universities and public schools, and among students in public schools (for collaborative work or video field trips). Meetings and staff development often take place via videoconferencing. Another widespread use is to disseminate information about the technology—an appropriate application, given interactive video's relative rarity.

The CPDTs have continued to seek out new technology to meet their needs for small-scale, person-to person interaction at a distance. Although "compressed video" (see Glossary) is well tailored to connect a teacher with students gathered at remote sites, it is not practical for linking 10 principals at scattered locations to one another and to district headquarters. Because education depends so centrally on human leadership and interpersonal communication, this need has been acute. Thus the CPDTs have quickly embraced tiny cameras (such as the See U C Me and VisiCam systems) costing only a few hundred dollars to provide interactive video connections for individuals via the Web. They will likely employ even more in the future.

A closer look at specific activities taking place at these and other sites illustrates how the potential of distance learning is being achieved.

Access

The access to educational resources provided by distance-learning systems addresses a central need in education, the need to level the playing field for all students and teachers. Distance learning delivers a variety of educational resources to locations where they could not otherwise be found. Many of the CPDTs have shown how access to expertise can invigorate the classroom for students and teachers alike. For example, in several west Texas schools, fourth graders no longer rely solely on out-of-date textbooks or library material to find out about space exploration. Instead, an interview with an astronaut has become the culminating activity of a unit. Students prepare a list of carefully honed questions like "How do you take a bath?" that keep the interchange lively for over an hour. For another example, Project

"At the Spindletop CPDT, Lamar University's students with hearing impairments have flocked to distance-learning classes because the emphasis on visuals and graphics fits their needs as learners far better than traditional lecture-style instruction does."

OWLink has booked medical specialists to work with science classes. Teachers testify to the inspiring effect that a talk with a famous heart surgeon can have on a health professions class.

But high-profile personalities are not essential to this effect. Expertise alone can be enough. Last year in Dallas, elementary school children studying weather decided that they would like to talk to a weather forecaster. Their teacher and CPDT personnel arranged a desktop videoconference with a meteorologist at the National Weather Service, who demonstrated the daily procedures that she follows and described the data with which she works.

The impact of such presentations is magnified when distance-learning equipment provides access for students isolated geographically. In Buna, rural east Texas fifth and sixth graders saw a Shakespeare production designed to introduce young children to the bard. Afterward there was a lively conversation with one of the actors. "You mean Juliet was played by a *boy*?" and "Did they really just throw their garbage out the window?" the students asked. The actor then tutored them as they rehearsed and performed a choral reading of a sonnet.

To cite one more example, 125 first-grade teachers in Brownsville Independent School District have taken a two-week distance-learning course in alphabetic phonics and early reading instruction from the Neuhaus Center in Houston, 500 miles away. Such intensive training in specialized techniques for teaching reading would not have been available to these teachers otherwise.

As distance learning breaks the barriers of geographic access, it also influences thinking about normal educational patterns and institutional boundaries, such as the boundary between high school and college. One of the chief demands for university courses has come from high schools. At several CPDTs, university professors offer freshman courses at times specifically chosen so that high school students can fit the courses into a normal high school schedule.

Distance learning also has provided improved access to education for special populations. At the Spindletop CPDT, Lamar University's students with hearing impairments have flocked to distance-learning classes because the emphasis on visuals and graphics fits their needs as learners far better than traditional lecture-style instruction does. Further, these students have sought out high-level training in teaching on distance-learning equipment because the delivery system may enable them to reach many hearing-impaired students at a time from different

schools spread over a large geographic region. Texas schools find it daunting to provide trained teachers for all their students with hearing impairments. Distance learning promises many public school students with such impairments far better access to educational resources than any other delivery system does.

Connection

A significant effect of distance learning results from its capacity to link individuals and groups who might learn from one another if they could connect. For example, PreK–12 schools, junior colleges, and universities traditionally have pursued their own goals in separate spheres. Even teacher education programs have not necessarily worked closely with public schools. Distance learning provides the means to create permanent connections between these sectors of education. Moreover, it requires that institutions come together to set goals and plan. In all such projects, the stakeholders must know what they receive from the joint effort as well as what they must give; different voices must be heard, and different goals, procedures, and schedules respected. The CPDTs have helped their sponsoring institutions establish collaborative relationships with public schools, junior colleges, and other universities, fostering the communication and the goal setting necessary to support distance learning. They also have played a key role in developing the governance structures and the operating procedures needed for continuing collaboration.

Connection has a particularly powerful effect on cross-cultural learning, and the CPDTs have shown that communication and collaboration via distance learning help students and teachers alike understand cultural differences. A dimension of Project OWLink is student-to-student and class-to-class projects between sites in Houston and the Rio Grande Valley, which are at opposite ends of the state (Miller & Kumari, 1997). In one project, students learn about one another as they cooperate on creative writing. In another project, students study the history of their own vocabulary and mathematical learning (**http://cttl.rice.edu**).

The CPDTs of the University of Texas at Brownsville and Prairie View A & M University sponsor a project called Cultural Connections (Cifuentes, Metcalf, Davis, & Gonzales, 1997). It connects Berta Cabeza Middle School in San Benito (in the lower Rio Grande Valley), Jones Intermediate School in Waller (in central Texas), Somerville Junior High (also in central Texas), and Central Heights Independent School District (in east Texas). The project uses "multimedia collaboration" to create new learning communities and promote cross-cultural understanding. Across the distance, students collaborate in creating

> ***"Distance learning now permits prospective teachers from a CPDT in west Texas to "look in" on a classroom in Port Arthur (in east Texas) with large numbers of Vietnamese and Cambodian students."***

Hyperstudio (software) presentations about their home lives, goals, thoughts and values, likes, abilities, and personal histories. As they work, they share their presentations, receive feedback, and make comparisons. So, for example, Dante in Waller shows Juan in San Benito his presentation. Juan pipes up, "I have three sisters too," then says, "Why don't you put a picture in?"

Final-presentation day is a major celebration of efforts. Students in south Texas "listened extra carefully . . . when one African-American student began talking," teachers report. "We didn't understand why at first, then we realized that some of our Hispanic students had never heard that dialect before and needed to listen very hard to understand."

The project has moved on to other kinds of joint activities: shared research, debates using persuasive arguments, and reading circles. Students use the distance-learning equipment to "call up" their peers every few days and compare progress or have group meetings. The project has been a runaway favorite of the students participating. Clearly, distance learning can create cross-cultural awareness and build an electronic community in which all students learn.

The power of connection and collaboration with peers is just as great for teachers (Metcalf & Nolan, 1997). In fact, connection promises equivalent benefits in both promotion of cultural diversity and co-learning. In the past, teacher training has been limited by place. Prospective teachers have done their student teaching at schools in the immediate area of their university. Thus those in east Texas have seen very few Hispanic students, and those in west Texas have known little about Vietnamese and Cambodian students. Distance learning now permits prospective teachers from a CPDT in west Texas to "look in" on a classroom in Port Arthur (in east Texas) with large numbers of Vietnamese and Cambodian students. The connection is scheduled so that the prospective teachers can observe a Diversity Day celebration. Immediately following the presentations by elementary school students, the prospective teachers participate in a videoconference with prospective teachers from the Port Arthur area, some of whom are Vietnamese and Cambodian. As they discuss cultural differences and similarities, they are heard to say, "Put your E-mail addresses up on the Elmo. We want to write you." Thus a two-way video hookup initiates a cross-cultural peer connection that continues via other technology.

Inservice teachers too have become regular beneficiaries of connection through distance learning. In the past, many have experienced isolation. CPDTs have broken that isolation in several ways: by offer-

ing graduate courses at times convenient to teachers; by setting up and facilitating videoconferences among teachers of similar subjects in remote locations; and by providing mentoring. Through distance learning, CPDTs encourage teachers to communicate with both experts and peers.

In the PARTNERS Project, the Baylor University CPDT has established distance learning as a key component of teacher education and teacher support ("The PARTNERS Project Promotes," 1997). Using videoconferencing units, this effort connects Baylor, Hillcrest Professional Development School in Waco, and Harker Heights Elementary School in Killeen Independent School District. Students sitting in education classes at Baylor observe classes taught at the two partner schools. Often, later in the day, students discuss what they saw with the classroom teacher—for example, why he or she did something or where he or she obtained particular information. University students query elementary school students as class is coming to an end, asking them how they liked specific activities or what they learned from certain ones. Baylor professors observe classes taught by student teachers and discuss and analyze teaching behavior.

Teachers from the two elementary schools have begun collaborative brainstorming and planning sessions using videoconferencing. The availability of the distance-learning equipment has encouraged such discussions, and teachers now refer to the technology as their "virtual teachers' lounge." As a result of this collaboration, teachers at two elementary schools sometimes co-teach a class.

The Trinity University CPDT also has made noteworthy use of distance learning in teacher education. First-year Trinity students interested in learning about school life, the connections between major institutions in society, and the possibilities for schools to become true communities enroll in Education 106, School and Community Seminar. Assigned to write a mini case study, the students visit the International School of the Americas. This magnet school in the Northeast Independent School District offers a rigorous, hands-on curriculum to a heterogeneous population of students (whose names are drawn from a hat). On their visit, Trinity students observe; interact with students, teachers, and community volunteers; and participate in programs, curriculum, and everyday events. Afterward, they reflect on their observations in writing, and their professor debriefs them.

Trinity students complete their data collection by discussing their findings in a videoconference with students and teachers from the

magnet school. To the conference they bring research questions based on their initial visits, and they query magnet school students and teachers about school issues related to their research. Trinity students also act as recorders during the conference, and their notes become research transcripts prepared by the professor for student use. Trinity students use direct quotations from the interviews to support major points in their papers.

In this example the videoconference adds significantly to students' learning. Time and transportation difficulties make a second round of campus visits impossible, but the distance-learning equipment allows the Trinity students a second, focused opportunity to gather more data and refine their inquiry. Creating a research transcript trains the Trinity students in a valuable research technique, and being scrutinized makes magnet school students and teachers realize anew that their work is significant. Ultimately the videoconference helps Trinity University keep building a community with its public school partners.

> ***"Personnel from several institutions that already have a CPDT share information, procedures, suggestions, and training with personnel from institutions that are hoping to establish a CPDT. For example, Lamar University has assisted five historically black private colleges in CPDT development."***

Another dimension of distance learning's connection is communication from teacher education program to teacher education program. Personnel from several institutions that already have a CPDT share information, procedures, suggestions, and training with personnel from institutions that are hoping to establish a CPDT. For example, Lamar University has assisted five historically black private colleges (members of the Texas Association of Developing Colleges) in CPDT development. To overcome their chronic shortages of teaching staff, the colleges have established distance-learning connections. Their long-range plan is to share instructional expertise, ultimately creating a "virtual CPDT." Lamar has assisted with installation of the distance-learning systems and has trained instructors (via distance learning) in student-centered, multimedia pedagogies.

Pedagogical Change

Teaching in a distance-learning classroom is a new and challenging experience. Teachers cannot simply continue to do what they have always done. They must master new technical skills and new strategies for student involvement. Indeed, some argue that the change in pedagogy demanded by distance learning is radical enough to constitute a change in kind, not just degree. According to Lawrence Clark (1997), in "Radical Technology + Radical Students = Radical Pedagogy,"

> It is necessary to develop a new pedagogy which not only embraces, but exploits, if you will, the numerous technologies which are currently or will soon be widely available to a growing number of

> our students. This development may be rapid or gradual, but there is no mistaking that it must take place. (p. 37)

Moving a course from traditional delivery to delivery by distance learning is time and labor intensive. As Dooley, Edmundsen, and Hobaugh (1997) argue,

> Faculty who teach at a distance must spend more time in planning and preparation for delivery. Typical transparencies and chalkboard techniques must be modified into computer graphics; access to resources such as library references, textbooks, laboratories, or computer facilities must be considered. (p. 56)

CPDTs have supported distance-learning efforts by providing a lot of training in both technology and pedagogy. The Project OWLink summer training sessions described earlier focus on integrating network and Internet connections into teaching. Teachers who take the OWLink training learn how to produce computer graphics for their Web sites; how to put together multimedia presentations for their students; and how to use Web resources (listservs, E-mail, and information searching) for instruction.

Baylor University's Project IDEAS has focused on changing pedagogy at the university level. Through a Teaching, Learning, and Technology Roundtable, the project provides faculty with training and support to convert courses to distance delivery. Project IDEAS has developed a complete course for faculty, with appropriate incentives (stipend or release time) for participation. More than 60 Baylor faculty members already have completed the course, and all faculty will have the opportunity for training within three years.

The Center for Distance Learning Research at Texas A & M University also assists faculty in converting courses to distance delivery, and it trains faculty members in distance-learning techniques (**http://www.cdlr.tamu.edu/cntrrsrv.htm**).

THE FUTURE: TRENDS AND ISSUES

Today, Texas educators can look back on a solid history of distance-learning efforts. Also, they can look ahead to distance learning becoming a major element of education, from kindergarten through the university. In retrospect, 1995–2000 will likely appear as a transition period when state educators moved from small-scale projects to large-scale institutionalization of distance learning. Institutionalization of distance

> ***"Research has firmly established that 'creating courses for distance learning is not merely a matter of applying distance-learning technologies to a successful traditional classroom lesson.'"***

learning was ensured in 1995 by the passage of House Bill 2128, which established the Technology Infrastructure Fund. Since its inception, this fund has been accumulating money from local, long-distance, cellular telephone, paging, and other telecommunication providers in Texas. In 1997, the fund had collected enough money to begin disbursing $150 million a year for 10 years in grants and loans for telecommunications, distance learning, information sharing, and telemedicine. A second resource established by House Bill 2128, the Technology in Education Fund, will be financed by mobile communication providers such as cellular telephone and paging companies. The funding formula is being challenged in court, but the fund is intended to receive $75 million a year for the activities just listed and for program development, materials, training, installation costs, and other purposes (*Summary*, 1995).

Although substantial funds will be available to support technology in education, it is not clear to what extent PreK–12 schools will make use of distance learning, nor is it certain that all universities will bear the additional costs of establishing distance-learning systems. Perhaps distance learning will become the domain of the largest institutions in the state and thus increase their dominance of education. Perhaps distance learning will be viewed strictly as a cost-cutting measure, and universities will use it only to deliver courses to tuition-paying students. Certainly the barriers to full access, full connection, and full pedagogical transformation are considerable.

A review of the past five years of distance-learning efforts in Texas and across the nation reveals several trends:

• *Growing evidence of the importance of training for instructors.* Teachers preparing to instruct on a distance-learning system need training in both technology and pedagogical techniques appropriate for distance learning. Moreover, research has firmly established that "creating courses for distance learning is not merely a matter of applying distance-learning technologies to a successful traditional classroom lesson" (Schrum, 1996, p. 31).

The issue of cost emerges here. Institutions must be willing not only to purchase equipment and sustain continuing line charges, but to undertake substantial teacher training.

• *Increased collaboration between educational institutions, crossing traditional boundaries between states, between public and private institutions, and between schools and colleges.* The most nota-

ble example of this trend, because it is the largest collaborative venture, is Western Governors' University. This proposed "virtual university" will broker postsecondary-level training across 13 western states. The system is intended to remove "barriers to the free flow of high-quality educational materials and recognized learning across institutional, state, and other boundaries" and to create a "competency-based approach to assessing and certifying learning at the postsecondary level" (*Western Governors' University*, 1996, p. 5). The university will review courseware and courses available from traditional, nontraditional, and commercial sources; select those that meet its criteria; and list them in an on-line catalog. To prevent Western Governors' University from competing with other higher education institutions in the states involved, it will not initiate new courses, but make existing high-quality courses accessible at more diverse locations (*Western Governors' University*, 1996).

The possible impact of this and other large-scale interstate projects is enormous. If the project realizes its potential, it will establish a new paradigm for postsecondary education, one that will fulfill distance learning's ultimate promise of nearly universal access to educational resources.

However, the prospect raises a parallel troubling issue. Will the courses made so widely available truly be of high quality? Will the ease of access to them drive less accessible and perhaps better alternatives out of the education market?

• *Increased emphasis on technology in education.* Distance learning is technology dependent. Teaching and learning at a distance simply do not happen unless the technology functions properly and the instructor controls it correctly. Hence the growing use of distance learning makes technological training for teachers at all levels, kindergarten through university, absolutely imperative.

However, the expense of distance learning highlights the disparity between education's haves and have-nots. Equitable funding of institutions is critical if the potential of distance learning is to be fully realized.

• *Increased importance of collaborative relationships among distance-learning partners.* Relationships among participants require thoughtful and careful maintenance, with equitable consideration for each participant's goals and resources. Because of this, there is a risk

> ***"Increasingly, instructors must consider the content and the goals of a course before selecting the technologies that they will use."***

that distance learning will be used simply as a delivery mechanism rather than a vehicle for collaboration and communication among education institutions and learners.

• *Increased standardization and flexibility of distance-learning equipment.* In recent years the emergence of industry standards for video compression has increased the compatibility of systems produced by different manufacturers, and hence greatly boosted the opportunities for connections. Also, the advent of quality video transmission over ISDN lines has opened myriad possibilities for contacts.

The growing choices of contacts and the ease of dialing up highlight the continuing importance of careful planning to achieve maximum educational effect. Distance-learning connections make collaboration and learning possible, but only thoughtful, informed teachers will make them real.

• *Growing importance of other interactive media such as the Web.* With increasing Web access and the development of inexpensive Web-based desktop videoconferencing units, room-scale videoconferencing is no longer the only fully interactive distance-learning medium available. Increasingly, instructors must consider the content and the goals of a course before selecting the technologies that they will use. A writing class may operate very well over the Internet with a minimum of video contact; an art course cannot. In fact, most courses need several technologies in combination.

• *Increasing evidence that delivery of university courses by distance learning is not the only educationally significant use of the technology.* Class-to-class collaborations, continuing collaboration among teachers, and classroom observations by preservice teachers are promising applications that should not be squeezed out by universities seeking a paying market. Proprietary uses of distance learning will no doubt surface as another threat to creative collaborative use.

Five years of pioneering efforts by the CPDTs have substantially increased the knowledge base about distance learning and its potential for education. Clearly, distance learning is a powerful tool for bringing education to those who have been underserved, it connects people who can learn from one another, and it transforms teaching. The charge now is to use this knowledge to insist that distance learning be used to its full potential.

Bandwidth. The quantity of digital signals that can be transmitted using a particular medium. Fiber optic lines provide very high bandwidth (equivalent to 39,000 telephone lines) and hence transmit regular video signals. T1 lines provide the equivalent of 24 telephone lines. A standard telephone line provides rather low bandwidth; two lines are minimum for videoconferencing and can transmit only video signals that have been compressed.

Bridge. Also known as a multipoint control unit (MCU). It enables three or more sites to participate in a videoconference.

Byte. "A group of eight binary digits processed as a unit by a computer and used esp. to represent an alphanumeric character" (*Webster's Collegiate Dictionary*, 10th ed., s.v.).

Compressed video. To allow high-quality video transmission over telephone lines, various commercial vendors now make units that compress the video signal. Commonly called CODECs, the units code and decode digitized video.

Desktop videoconferencing. A type of videoconferencing system that uses a very small "eyeball" camera connected to a personal computer and transmits image and sound via a modem and the Web to a similarly equipped computer.

Document camera. A small camera over a flatbed that transmits the image of anything at which it is aimed (paper, object, artwork, etc.) to a video monitor. This is the 21st-century version of the overhead projector.

DS-0. A standard telephone line, transmitting at 56 kilobytes per second, or 64 kilobytes per second for ISDN.

DS-1. Commonly known as T1 capacity—24 DS-0's at 64 kilobytes per second, or 1.544 megabytes per second.

Fiber optic. Special cables that are capable of transmitting at a rate of 2.5 gigabytes per second. Fiber optic is expected gradually to replace all other types of cabling now used for telephone and other electronic communication devices.

Gigabyte. A unit of computer information storage capacity equal to 1,073,741,824 bytes, or 1,024 megabytes.

H.320. The current standard for video compression. Adherence to this standard results in compatibility among videoconference units from different vendors.

Kilobyte. A unit of computer information storage capacity equal to 1,024 bytes.

Megabyte. A unit of computer information storage capacity equal to 1,048,576 bytes, or 1,024 kilobytes.

T1. A trunk telephone line capable of transmitting at the rate of 1.544 megabytes per second. It carries 24 standard DS-0 telephone lines.

REFERENCES

Adams, M., & Irwin, L. (1997). Distance learning takes a learner centered approach. In *Conference Proceedings of the Fourth National Distance Education Conference*. College Station: Texas A & M University, Center for Distance Learning Research.

Cifuentes, L., Metcalf, T., Davis, T., & Gonzales, E. (1997). Cultural Connections: A multimedia distance learning project. In *Conference Proceedings of the Fourth National Distance Education Conference*. College Station: Texas A & M University, Center for Distance Learning Research.

Clark, L. (1997). Radical technology + radical students = radical pedagogy: On creating a virtual learning environment in cyberspace. In *Conference Proceedings of the Fourth National Distance Education Conference*. College Station: Texas A & M University, Center for Distance Learning Research.

Cunningham, C., & Bernshausen, D. (1997). *The inevitable innovation*. Paper presented at the Texas Center for Educational Technology Symposium, Dallas.

Dooley, K., Edmundsen, C., & Hobaugh, C. (1997). Instructional design: A critical ingredient in the distance education soup. In *Conference Proceedings of the Fourth National Distance Education Conference*. College Station: Texas A & M University, Center for Distance Learning Research.

Dooley, L. (1996). Administration of distance education programs. *Distance Education Certification Program participant workbook*. College Station: Texas A & M University, Center for Distance Learning Research.

Johnson, A. (1997). *Distance learning in professional development schools: A Texas perspective*. Paper presented at SITTE '97, Orlando, Florida.

Metcalf, T., & Nolan, S. (1997). Technology for educator development: What is it? Why do we need it? What do we hope to accom-

plish? In *Conference Proceedings of the Fourth National Distance Education Conference*. College Station: Texas A & M University, Center for Distance Learning Research.

Miller, L., & Kumari, S. (1997). Project OWLink: Distance learning in electronic studios. In *Conference Proceedings of the Fourth National Distance Education Conference*. College Station: Texas A & M University, Center for Distance Learning Research.

Moore, M., & Kearsley, G. (1996). *Distance education: A systems view*. Belmont, CA: Wadsworth.

The PARTNERS Project promotes technological innovation. (1997). *Images . . . of Technology in Texas Schools*, No. 21. Denton: University of North Texas, Texas Center for Educational Technology.

Russell, T. (1996). *The "no significant difference" phenomenon*. Raleigh, NC: North Carolina State University, Office of Instructional Telecommunications.

Schrum, L. (1996, March). Teaching at a distance: Strategies for successful planning and development. *Learning and Leading with Technology, 23*, 30–33.

SETTEN: A regional telecommunications network. (1997). Beaumont, TX: Region V Educational Service Center.

Smith, N. (1997). Student perceptions of the distance learning experience. In *Conference Proceedings of the Fourth National Distance Education Conference*. College Station: Texas A & M University, Center for Distance Learning Research.

Summary of House Bill 2128. (1995). Austin: Texas Education Agency.

Technology plays a major role in new approaches to the education of teachers and students in the SWT–CPDT. (1995). *Images . . . of Technology in Texas Schools*, No. 9. Denton: University of North Texas, Texas Center for Educational Technology.

Trans-Texas Videoconference Network annual report. (1996). College Station: Texas A & M University.

Video teletraining: A guide to design, development, and use. (n.d.). Washington, DC: General Accounting Office.

Western Governors' University: A proposed implementation plan. (1996). Denver: Western Governors' Association.

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